CLAIMS

The embodiments of an invention in which an exclusive property or right is claimed are defined as follows:

1. A vertical cavity surface emitting laser, comprising:

a substrate;

an active region adjacent said substrate;

a first mirror between said active region and said substrate; and

a second mirror adjacent said active region, said active region being between said second mirror and said first mirror;

wherein said second mirror includes an oxide insulating region; and

wherein said oxide insulating region, said active region, and at least a portion of said second mirror include damage from implanted ions.

2. The vertical cavity surface emitting laser of claim 1, wherein said oxide insulating region and said damage from said implanted ions define a high resistance region that substantially confines current flow through an inner portion of said high resistance region.

3. The vertical cavity surface emitting laser of claim 3, wherein said high resistance region is shaped as an annular ring.

4. The vertical cavity surface emitting laser of claim 1, further including a spacer between said active region and said second mirror, wherein said spacer includes damage from said implanted ions.

5. A vertical cavity surface emitting laser, comprising:

a substrate;

a first mirror on said substrate;

a first spacer on said first mirror;

an active region on said first spacer;

a second spacer on said active region;

a second mirror on said second spacer;

wherein said second mirror includes an oxide insulating region; and

wherein said oxide insulating region, said second spacer, said active region, and at least a portion of said second mirror includes damage from implanted ions.

6. The vertical cavity surface emitting laser of claim 5, wherein said second mirror is comprised of aluminum-containing III-V compound semiconductors, and wherein said oxide insulating region includes an aluminum oxide.

7. The vertical cavity surface emitting laser of claim 6, wherein said second mirror includes an aluminum-containing layer whose group III composition is more than 95% aluminum.

8. The vertical cavity surface emitting laser of claim 7, wherein said aluminum-containing layer is oxidized.

9. The vertical cavity surface emitting laser of claim 5, wherein said oxide insulating region extends into said second spacer.

10. The vertical cavity surface emitting laser of claim 9, wherein said oxide insulating region is shaped as an annular ring.

11. The vertical cavity surface emitting laser of claim 5, wherein said substrate is n-type.

12. The vertical cavity surface emitting laser of claim 5, further including a p-type conduction layer over said second mirror, a p-type cap layer over said p-type conduction layer, and a p-type electrical contact over said p-type cap layer, wherein said p-type electrical contact includes an opening for light emission.

13. The vertical cavity surface emitting laser of claim 5, further including an n-type conduction layer over said second mirror, an n-type cap layer over said n-type conduction layer, and an n-type electrical contact over said n-type cap layer, wherein said n-type electrical contact includes an opening for light emission.

14. A method of forming a vertical cavity surface emitting laser, comprising:

forming a first electrical contact on a substrate;

forming a first mirror structure on the substrate;

forming a first spacer on the first mirror structure;

forming an active region on the first spacer;

forming a second spacer on the active region;

forming a second mirror on the second spacer, wherein the second mirror includes a high aluminum content layer;

forming a conduction layer over the second mirror;

forming a cap layer over the conduction layer;

forming a second electrical contact on the cap layer;

oxidizing the high aluminum content layer to form an oxide layer; and

damaging the oxide layer, the second spacer, and at least part of the active region by implanting ion to form a current confining region.

15. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein forming the active region includes forming a quantum well.

16. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the oxide layer is formed with an annular shape.

17. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein implanting ions produces non-radiative recombination centers in the active region.

18. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein forming the second electrical contact includes forming an opening for light emission.

19. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein forming the first electrical contact on the substrate includes forming an n-doped substrate.

20. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein forming the second mirror on the second spacer includes forming a p-doped second mirror.

21. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the first spacer is a lower spacer.

22. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the second spacer is a top spacer.

23. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the high aluminum content is more than about 95% aluminum.

24. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the high aluminum content is in a range of 97-98% aluminum.

25. The method of forming a vertical cavity surface emitting laser according to claim 14, wherein the current confining region has high resistance.